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Optimizing IV&V Benefits Using Simulation

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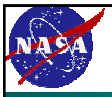
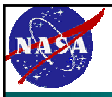


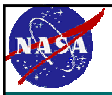
Motivation

- There is a critical need for cost effective IV&V
- Key Questions:
  - What is the benefit of a given IV&V technique?
  - How can the economic benefit of IV&V technologies be optimized?
  - At what point in the development process should an IV&V technique be inserted? How does the benefit change?



Optimizing IV&V Benefits Using Simulation

- Long Term Goal:
  - Decision support tool that can recommend an optimal portfolio of IV&V techniques for a given project
- First Year Goal:
  - To develop prototype models for one development process used on NASA projects and one IV&V technique in order to illustrate the capabilities of SPSM technology



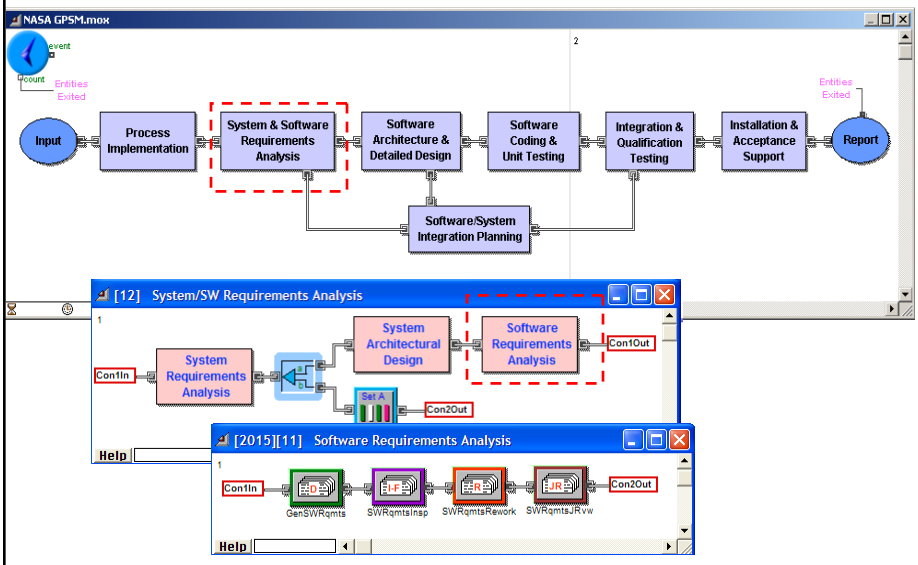
Key Features of Our Approach

- Graphical Models of the Process
- Software Process Simulation Models (SPSMs) uniquely capture the structure of the development process at a detailed level
- Predict performance in terms of cost, quality and schedule
- SEI Process Definition Approach to Process Modeling
- Process Tradeoff Analysis Method (PTAM)
  - Integrated decision support framework
- Designed for rapid deployment

Questions of Interest to NASA IV&V

- What would be the costs and benefits associated with implementing a selected IV&V technique on a selected software project?
- What is the benefit if a given IV&V technique is applied at different insertion points in the development process or applied multiple times?
- What is the benefit of applying one combination of IV&V techniques to a given process vs another?
- How can the economic benefit of IV&V technologies be optimized?

NASA Contractor's Development Process



Applying IV&V Technique in Parallel

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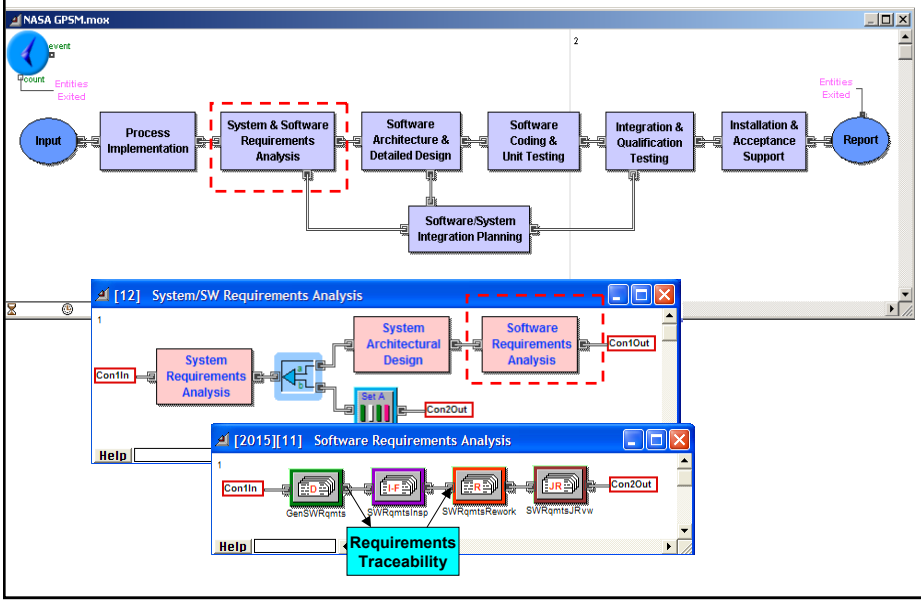

Applying IV&V in Sequence

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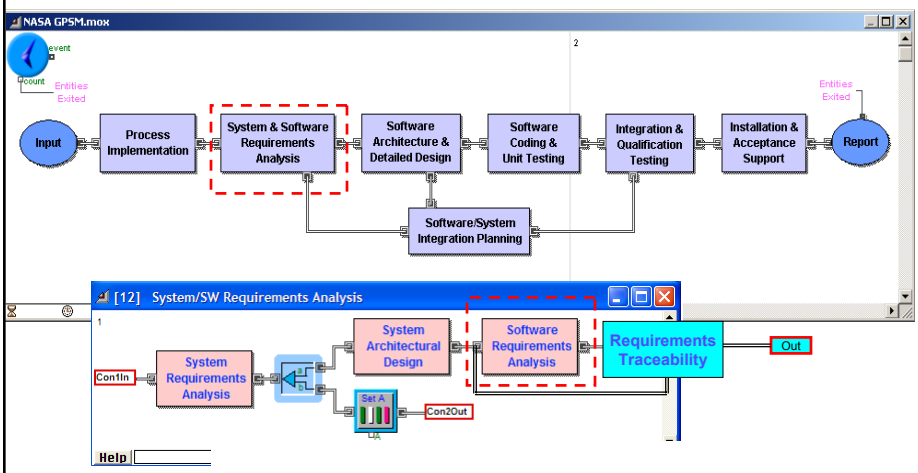

Applying IV&V at the Top Process Level

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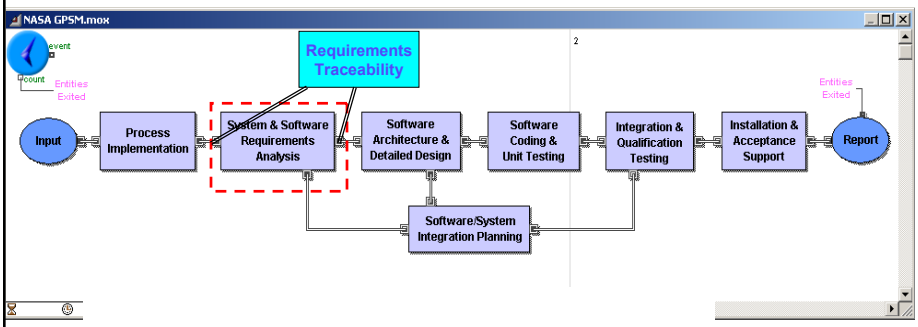

Applying IV&V Later in the Process

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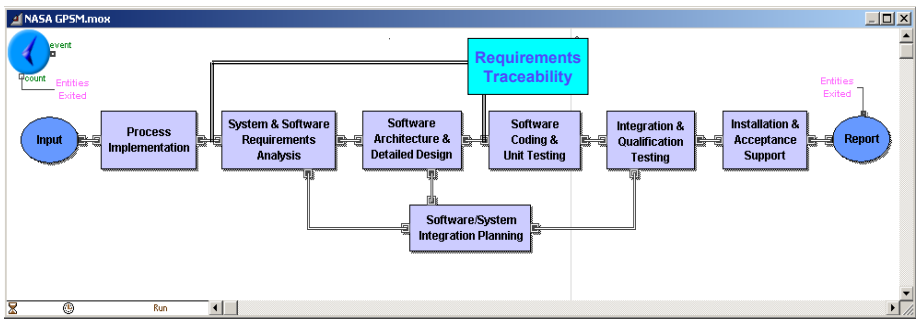
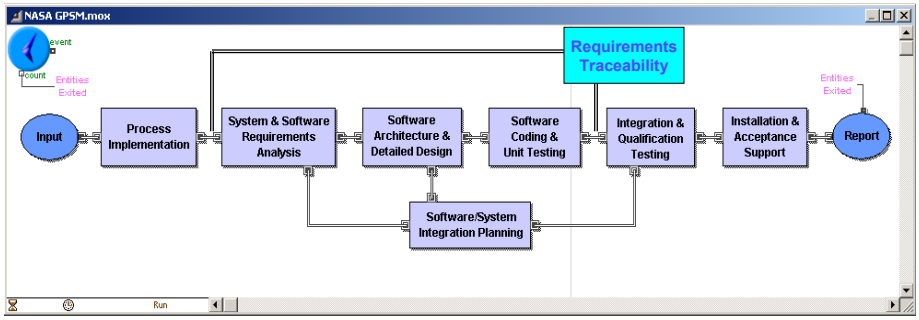
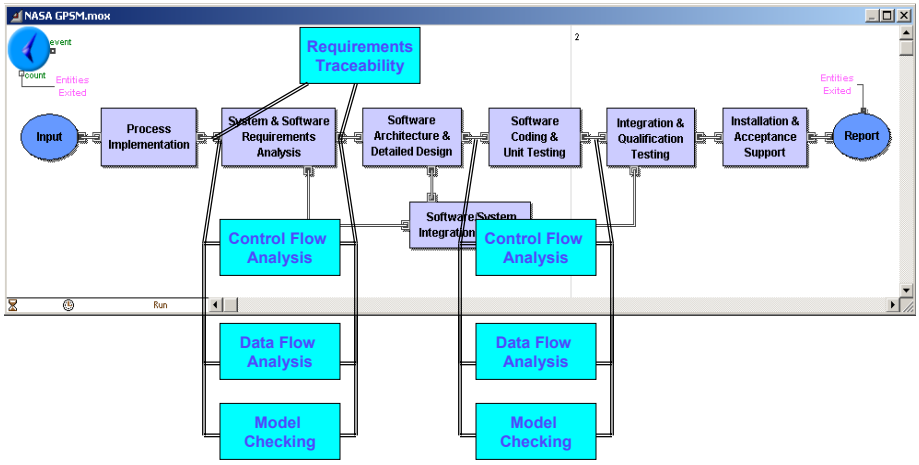


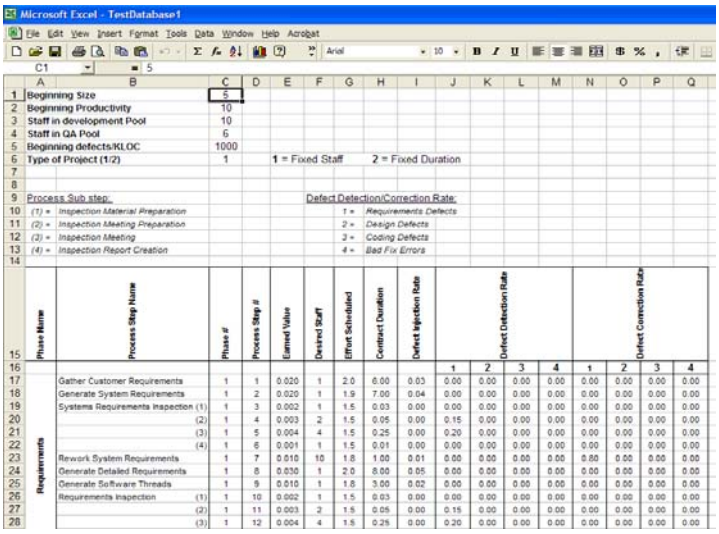
Applying IV&V During Testing



Applying Multiple IV&V Techniques at Multiple Points in the Process



Modify Parameters from Pre-set Values Based on Actual Data



Microsoft Excel - TestDatabase1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Beginning Size		5														
2	Beginning Productivity		10														
3	Staff in development Pool		10														
4	Staff in QA Pool		6														
5	Beginning defects/KLOC		1000														
6	Type of Project (1/2)		1		1 = Fixed Staff				2 = Fixed Duration								
7																	
8																	
9	Process Sub step:								Defect Detection/Correction Rate:								
10	(1) =	Inspection Material Preparation							1 =	Requirements Defects							
11	(2) =	Inspection Meeting Preparation							2 =	Design Defects							
12	(3) =	Inspection Meeting							3 =	Coding Defects							
13	(4) =	Inspection Report Creation							4 =	Bad Fix Errors							
14																	

15	Phase Name	Process Step Name	Phase #	Process Step #	Earned Value	Desired Staff	Effort Scheduled	Contract Duration	Defect Injection Rate	Defect Detection Rate				Defect Correction Rate			
16										1	2	3	4	1	2	3	4
17	Requirements	Gather Customer Requirements	1	1	0.020	1	2.0	6.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18		Generate System Requirements	1	2	0.020	1	1.9	7.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19		Systems Requirements Inspection (1)	1	3	0.002	1	1.5	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20		(2)	1	4	0.003	2	1.5	0.05	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21		(3)	1	5	0.004	4	1.5	0.25	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22		(4)	1	6	0.001	1	1.5	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23		Rework System Requirements	1	7	0.010	10	1.8	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24		Generate Detailed Requirements	1	8	0.030	1	2.0	8.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25		Generate Software Threads	1	9	0.010	1	1.8	3.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26		Requirements Inspection (1)	1	10	0.002	1	1.5	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27		(2)	1	11	0.003	2	1.5	0.05	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28		(3)	1	12	0.004	4	1.5	0.25	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Potential Model Output

- Baseline Development Process without IV&V
  - Development Cost 527 person-months
  - Project Schedule 18 months
  - Product Quality 117 Delivered defects
- Development Process Performance with IV&V –
  - Requirements Traceability (parallel) 521 PM, 17 M, 83 D
  - Requirements Traceability (sequential) 523 PM, 16 M, 85 D
  - Requirements Traceability (During Coding) 523 PM, 17 M, 86D
  - Requirements Traceability (During Testing) 524 PM, 17 M, 88 D
  - Combination 1 (RT, CFA, DFA, MC) 503 PM, 16 M, 78 D
  - Combination 2 (RT, CFA, DFA, MC) 507 PM, 16.5 M, 61 D
  - Etc.
- ***Determine return on investment and rank order for optimal IV&V allocation***

IV&V Business Case

- For the Project X, using process Y
- Midex project, 1500 FP, using C++
- Option #7 gave best results:
- IV&V Techniques planned:
  - Traceability applied at Requirements and Detailed design, and Coding
  - Model Checking applied at High-level and detailed design
- Estimated IV&V Cost = $1.5 Million
- Estimated Cost Savings = $3.1 Million
- Estimated Return on Investment = 2.07

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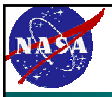
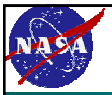
Data Requested

Data Category	Items Requested
Process	Process diagrams, work flow diagrams or value mappings of the full Software Development Life Cycle and sub-steps
Product	Size of software being developed by CSCI and by CSC if possible
Effort	Productivity, earned value, number of staff, number of hours of effort by activity by CSCI. We need to understand the effort consumed by development, rework, inspections and testing activities.
Schedule	Duration of each process step from earliest start to last finish
Defects	Defects injected and detected by type by phase



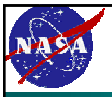
Current Status and Accomplishments

- Verifying and Validating Prototype Tool
- Developed model of IEEE 12207 software development process complete and corresponding data set
- Delivered memo identifying initial data needs
- Developing workflow models of IV&V techniques
- Looking for data



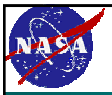
Potential Contributions to NASA IV&V

- Justify the costs of IV&V to NASA projects
- IV&V 'What-If' Calculator to assess the cost-benefit trade-offs between different IV&V techniques
- Models to evaluate the structure and quality of the process (IV&V Software Development Process)
- A method to cost-justify a particular IV&V plan versus an alternate proposal made by the projects.



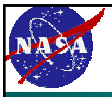
Potential Contributions to NASA IV&V (cont)

- An ability to assess the benefit if a given IV&V technique is applied at different insertion points in the development process or applied multiple times.



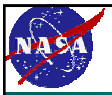
Future Plans

- Develop Versions 2 and 3 of the Simulation Tool
- Incorporate multiple new software development lifecycle process templates into the tool
- Incorporate additional IV&V techniques into tool
- Design report templates tailored for IV&V
  - Special tracking for IV&V resources



Future Plans

- Integrate the Simulation tool with the ICE tool
- Incorporate ROI results from other initiatives
- Transfer this tool to NASA



Conclusions

- Simulation modeling is a viable approach for assessing the costs and benefits of IV&V on NASA projects
- Not a silver bullet
- Process Tradeoff Analysis Method supports decision making
  - Gives framework and focus to metrics program
  - Supports business case development for process improvement by assessing the financial benefit associated with IV&V activities.
  - Provides quantitative risk assessment of benefit

Conclusions

- Supports higher software development maturity
  - Training, Process Definition, and Metrics Definition (Levels 2 and 3)
  - Quantitative Process Management and Software Quality Management (Level 4 KPAs)
  - Defect Prevention, Process Change Management, Technology Change Management (Level 5 KPAs)

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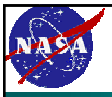
The End



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